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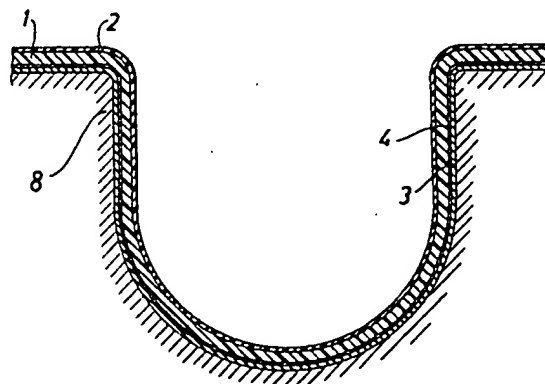
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54 A laminate together with a method for its manufacture.

57 The invention relates to a laminate comprising an aluminium layer and a polyester layer, the aluminium foil layer being wrinkled or contracted into a large number of wrinkles which can be straightened out when the plastic material is stretched, without any breaking of the aluminium foil layer.





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(54) A laminate together with a method for its manufacture.

(57) The invention relates to a laminate comprising an aluminium layer (4) and a polyester layer (1), the aluminium foil layer being wrinkled or contracted into a large number of wrinkles which can be straightened out when the plastic material is stretched, without any breaking of the aluminium foil layer.

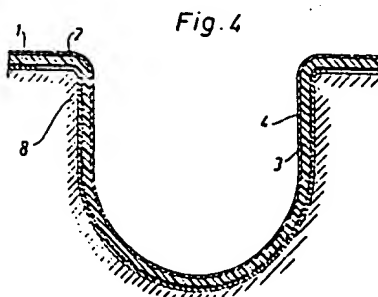


Fig. 4

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A LAMINATE TOGETHER WITH A METHOD FOR ITS MANUFACTURE

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The present invention relates to a laminate comprising on the one hand a layer of a metal foil, in particular aluminium foil, together with one or more layers of plastic film as well as a method for the manufacture of such a laminate.

Aluminium foil has been used for a long time in connection with packaging as an item included in laminate together with plastic material or paper layers and plastic material. When a material for packaging of a certain product is chosen, the properties of the packing material must be adapted to the requirements of the product in respect of a protective barrier. A liquid product thus must be packed in a liquid-tight and liquid-resistant material, an oily product in an oil-resistant material and so on. In order to be able to seal the packages in an effective and convenient manner, the inside of the packing material is often provided with a heat-sealable plastic layer, and if stiffness of the packing material is required, a layer of paper or similar material is generally used. In other words a packing material is prepared, which has the properties which are desired, by laminating different material layers to each other. One characteristic that is desirable for many packing material combinations is tightness against gases, especially oxygen gas. Most plastic materials have poor oxygen gas barrier properties and it is for this reason, if gas-tightness is required, that in general a layer of metal foil, in particular aluminium foil, is incorporated in the packing laminate. An aluminium foil has outstanding gas-tightness characteristics even if the foil is extremely thin (e.g. 5  $\mu$ m) and such an aluminium foil layer also provides optimum light-protection properties which are required in many cases. For this reason aluminium foil has found wide application as a constituent in packing laminate, especially in connection with the type of packages which are formed by folding, welding together to bags or cushions etc. It is a disadvantage of aluminium foil laminate of the aforementioned type, that it cannot be stretched or deep-drawn or at least deep-drawn only to a very small degree. Most plastic materials can be readily subjected to a plastic deformation by heating the plastic material, whereupon it can be formed through drawing, blowing etc., the forming taking place so that the surface of the plastic material is extended with simultaneous

thickness reduction of the material. The forming of a large number of packages takes place just so, that a plastic material is form-processed by stretching, deep-drawing or blowing so as to produce a cavity into which the contents can be introduced. If such a forming were to be carried out on a laminate comprising an aluminium foil layer, the aluminium foil layer would break almost immediately, as a result of which the gas-tightness characteristics of course, would be lost.

Since aluminium foil possesses many characteristics which are desirable in connection with packaging, attempts have been made to develop an aluminium laminate suitable for deep-drawing. In principle it is known that aluminium in thicker layers readily can be formed by deep-drawing, but the problem is that rolled foils of thicknesses of 5 - 10  $\mu\text{m}$  break at relatively modest elongation. Successful attempts have been made, however, to manufacture relatively shallow troughs, plates and the like from laminated material comprising an aluminium foil, and a report on these experiments was published in the journal *Verpackungsrundschau* no. 4 of the year 1977 (N. Buchner, D. Liede, W. Brose - Aluform - Eine neue Packung aus Aluminiumkunststoff verbunden). In this paper an account is given, among other things, of how the constitutional structure of the aluminium material affects the deep-drawing capacity of the material, and a curve is also included showing the breaking elongation of aluminium foil as a function of the thickness of the aluminium foil. It is evident from this curve that the breaking elongation for aluminium foil of a thickness of 5 - 10  $\mu\text{m}$  is as low as 2-3%, whilst the breaking elongation of aluminium foil with a thickness of 140  $\mu\text{m}$  is as high as 32%, after which the breaking elongation, in principle, does not increase with increasing thickness of the aluminium foil. In the article it is also explained, how the deep-drawing capacity of a laminate containing aluminium foil can be increased by attaching the aluminium foil in the laminate to a polypropylene film, which imparts very good and uniform transfer of tensile strength to the aluminium foil during further form-processing.

The problem which has been stated has been solved by means of the present invention which has the characteristics furnished in the claims.

In the following the invention will be described with reference to the enclosed schematic drawing, wherein

Fig.1 a) and b) shows a greatly enlarged cross-section of a plastic laminate before and after an orientation stretching.

Fig.2 a) and b) shows how the oriented laminate in accordance with fig.1 b) is joined together with an aluminium foil and a plastic coating combined with the aluminium foil.

Fig.3 shows the laminate in accordance with the invention after the plastic foil, stretched earlier, has been made to shrink again, and

Fig. 4 finally shows by way of example how the laminate in accordance with the invention can be deep-drawn.

In the manufacture of the laminate in accordance with the invention it is assumed, in the present case, that the plastic portion consists of a polyester film 1 which has a coating 2 of so-called glycol-modified polyester (PETG). The laminate in accordance with the invention may be manufactured using other plastic materials, e.g. polypropylene, polyethylene, polyvinyl chloride etc., but since the polyester material has certain characteristics which are desirable in many cases, we chose to describe the invention on the basis of polyester (PET) as the plastic constituent of the laminate.

It is known that polyester can be given very good tensile strength if the material is molecular-oriented through stretching. Unfortunately the material then obtains a mainly crystalline molecular structure which means that the material cannot be heat-sealed. In recent times, however, a so-called glycol-modified polyester material (PETG) has been put forward, which largely retains its amorphous structure, even after orientation stretching. This material consequently is heat-sealable after the orientation stretching, provided the stretching is not carried too far, but it does not acquire the same tensile strength as the oriented, crystalline polyester material. The two materials PET and PETG are so similar in character, however, that they can be readily combined by surface fusion and it is also possible by one and the same extrusion process (co-extrusion) to extrude a film consisting of one layer of PET and one or more layers of PETG. Such a material combination is shown in fig. 1 a).

The laminate in accordance with fig. 1 a) may be subjected to a monoaxial or biaxial stretching at a temperature not exceeding 90°C. The result of this stretching operation will be, of course, that the material, which is shown in fig. 1 b), will become thinner, at the same time as the surface of the stretched material is enlarged. Moreover, the layer 1 is molecular-oriented so as to form the oriented layer 1' which has a substantially better tensile strength than the non-oriented layer 1 in fig. 1 a).

If the laminate in accordance with fig. 1 b) is heated to 90°C or more, the built-in stresses, which are produced during the molecular orientation, will be released, and the material will shrink until, in principle, it has returned to its original shape. This means that an aluminium foil which is to be laminated to the material has to be combined with the laminate in accordance with fig. 1 b), without the same being heated to such a degree that the orientation stresses are released and the material is caused to shrink. In accordance with fig. 2 a) the laminate in accordance with fig. 1 b) is to be combined with the aluminium foil 4, which in general is so thin (5 - 10  $\mu\text{m}$ ) that in order to be handled it has to be covered first with a plastic coating 3. This plastic coating 3 may be constituted of polyethylene and it may be very thin, but it may also be constituted of PETG material. If the surface layers of the final laminate should be capable of being sealed to one another, for example for the formation of a pipe, it is appropriate instead to cover the aluminium foil layer 4 with a layer 3 of PETG. The PETG layer may be constituted either of a very thin coating which without difficulty can be made to shrink together with the layer 1', but it may also consist of a PETG film, orientation-stretched in advance, which is laminated to the aluminium foil 4 with the help of an intermediary adhesive layer. As mentioned earlier, the "primary laminate" of PET and PETG cannot be heated in connection with the lamination of the aluminium foil, since the oriented laminate, otherwise, would be caused to shrink. Instead it is appropriate to join together the aluminium foil layer 4 with the oriented PET layer 1' with the help of an intermediary adhesive coating, e.g. glue (EVA-glue) or a varnish, at a temperature remaining below the shrinkage temperature of the laminate. It is important, however, to obtain a very good attachment between the aluminium foil layer 4 and

the orientation-stretched PET layer 1', since otherwise delaminations may occur in connection with the shrinkage of the laminate.

When the laminate in accordance with fig.2 b) has been completed, the whole laminate is heated uniformly so as to cause it to shrink to its original dimensions. This heating may be done so that the laminate is immersed in a liquid which previously has been heated to a temperature exceeding the shrinkage temperature of the laminate, or else the laminate can be passed through a warm oven of a corresponding temperature. The extent to which the laminate shrinks will depend, of course, on the original stretching of the "primary laminate". In the case of polyester it is readily possible to stretch the material 4 to 5 times its original length in both longitudinal and transverse direction, which may mean a surface enlargement of the material during the stretching operation of up to 25 times, and thus a corresponding surface reduction when the laminate is shrunk.

When the laminate in accordance with fig.2 b) is heated a shrinkage will take place, as mentioned earlier, which in principle corresponds to the previous stretching, and the shrunk laminate is shown in fig.3. This shrinkage operation means, of course, that the thickness of the laminate increases at the same time as its surface diminishes, and what happens with the aluminium foil layer 4 is that it is wrinkled or contracted to a great number of wrinkles or contraction points which are so small that they cannot be conceived with the naked eye. Purely optically the contraction expresses itself in such a manner that the earlier mirrorlike aluminium foil becomes duller and loses its gloss. If the adhesion between the aluminium layer and the remaining material layers is good, however, the bond between the plastic layer and the aluminium foil will be retained along the whole of the surface of the aluminium foil.

The laminate in accordance with fig.3 now can be used for the manufacture of deep-drawn objects and in fig.4 is shown an example of such a deep-drawing. In the deep-drawing operation the laminate is heated in known manner to such a degree that the plastic material is caused to melt, whereupon the laminate is formed with the help of a forming plunger or with the help of compressed air or vacuum to lie accurately against a mould 8. In the present case it had to be

ensured that any stretching of the laminate in accordance with fig. 3 during the forming in accordance with fig.4 does not at any point exceed the shrinkage of the material which has taken place earlier. Practical experiments have shown that the laminate in accordance with fig.3 can be stretched almost to the same extent as that to which the laminate previously has been shrunk, that is to say so, that the wrinkles or contractions of the aluminium foil are "straightened out". This stretching limit must not be exceeded, though, since the aluminium foil would then break immediately.

It has been found that, through the application of the invention and utilization of the laminate in accordance with fig.3, a deep-drawing effect can be attained which is more than 10 times greater than what has been achieved previously and which has been reported in the journal Verpackungs Rundschau mentioned earlier. Such an increase in deep-drawing capacity of an aluminium laminate is, of course, of great commercial and practical value and it is possible with the help of the invention to manufacture e.g. preserve jars with an aluminium foil thickness of 5  $\mu$ m or 5/1000 mm, whereas the wall thickness of a normal aluminium preserve jar in general is not less than 1/10 mm, that is to say a twentyfold reduction of the container thickness.

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The embodiment of the invention described here relates to a laminate between polyester and aluminium foil, but, as mentioned earlier, it is readily possible to apply the invention also to other laminate combinations. Thus it is possible to start off from a co-extruded three-layer material with a central layer of PET which on both sides has coating layers of PETG and, after the stretching operation, laminate an aluminium foil layer to one of the said PETG layers with the help of a varnish, whereupon a further PETG layer may be extruded onto the aluminium foil layer.



CLAIMS

1. A laminate comprising on the one hand a layer of a metal foil, in particular aluminium foil, and on the other hand one or more layers of a plastic film characterized in that the metal foil layer, at least along one region intended for stretching or deep-drawing processing, is wrinkled or contracted into a very tight wrinkling or contraction pattern.

2. A laminate in accordance with claim 1, characterized in that the metal foil layer is attached to an adjacent plastic film or plastic films with very good adhesion.

3. A laminate in accordance with claim 1, characterized in that the metal foil layer is covered on both sides with a plastic layer.

4. A laminate in accordance with claim 1, characterized in that the plastic material is constituted of polyester.

5. A laminate in accordance with claim 1, characterized in that the metal foil layer is attached to said plastic layers with the help of an intermediary adhesion layer.

6. A method for the manufacture of a laminated material suitable for deep-drawing or stretching in accordance with claim 1, characterized in that in a first operation one or more plastic film layers are subjected to a molecular-orientation stretching, that the metal foil layer in a second operation is laminated to the orientation-stretched plastic layer or layers, and that finally the laminate formed is heated to such a degree that the oriented plastic layer or layers are caused to shrink, the plastic layers during the shrinkage operation at the same time contracting the metal foil layer.

7. A method in accordance with claim 6, characterized in that the metal foil layer is laminated to a plastic layer, orientation-stretched in advance, the lamination being carried out at such a low temperature that the oriented plastic layer is

not caused to shrink, and that the metal foil layer, moreover, is coated with a plastic layer or is laminated to a plastic film so as to be enveloped on both sides by plastic material.

8. A method in accordance with claim 6, characterized in that the orientation-stretched plastic foil is constituted of largely crystalline polyester and that the outer layers of the laminate are constituted of largely amorphous, so-called glycol-modified polyester (PETG).

9. A method in accordance with claim 7, characterized in that the lamination is performed with the help of an adhesion varnish or a glue.

Fig 1a

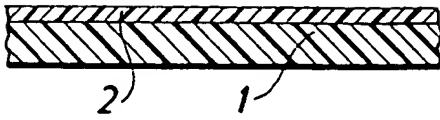


Fig.1b

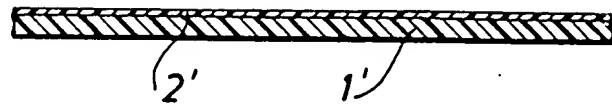


Fig.2a

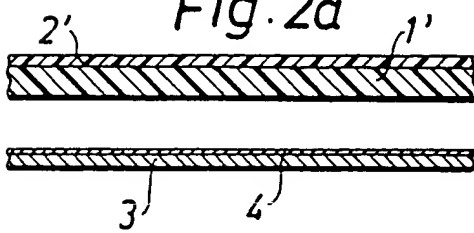


Fig 2b

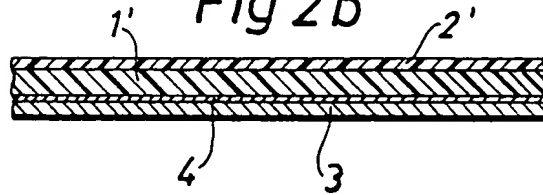


Fig.3

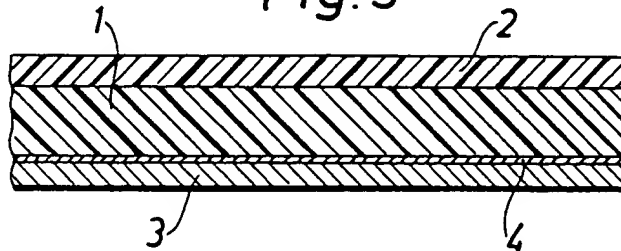
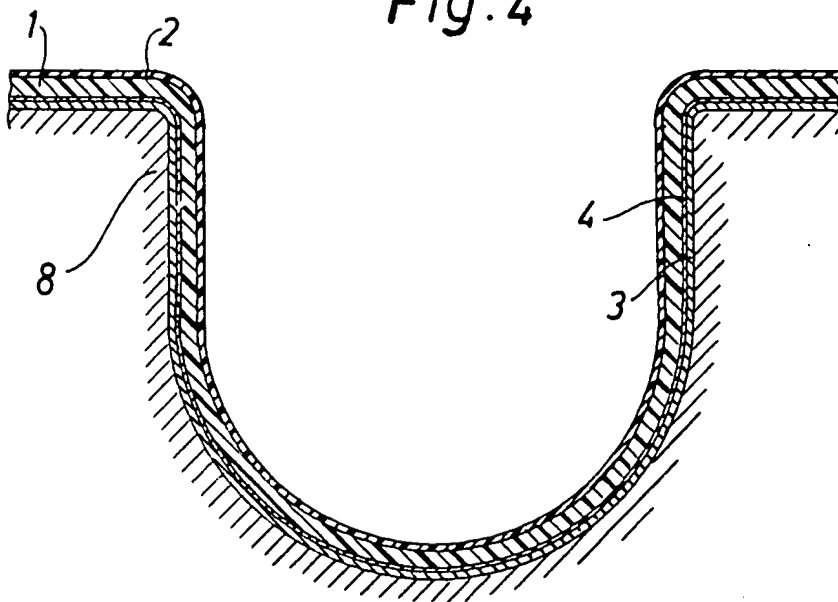


Fig.4





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# EUROPEAN SEARCH REPORT

0084827

Application number

EP 83 10 0308

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 7)
X	DE-B-1 230 546 (G. KAUPERT) * Whole document *	1, 2, 5	B 29 C 17/03 B 29 C 25/00 B 32 B 15/08
A	DE-A-2 742 898 (MITSUBISHI PLASTICS IND.) -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl. 7)
			B 29 C B 32 B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 10-05-1983	Examiner VAN THIELEN J.B.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	